Health Consultation

Arkwood Inc. Superfund Site

Highway 65 1MS

Omaha, Boone County, Arkansas 72622

EPA Identification Number: ARD084930148
Site ID: 0600124

Prepared by
Arkansas Department of Health

MAY 11, 2016

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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SUMMARY

INTRODUCTION

The Arkwood, Inc. site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL, *a.k.a.* Superfund). The former wood treatment facility was found to be contaminated with volatile organic compounds (VOCs) and dioxins. In the 1990's, a Record of Decision (ROD) was issued and site remediation was implemented. Recently, due to EPA updates of dioxin guidelines, the soil at the Arkwood site has been reevaluated. EPA Region 6 Superfund Division requested a review of the soil data for public health evaluation. This evaluation includes a review of 28 soil samples collected in October 2014 using the adolescent trespasser exposure scenario.

CONCLUSION

The Arkansas Department of Health (ADH) and the Agency for Toxic Substances and Disease Registry (ATSDR) conclude that current dermal (skin) and/or incidental (accidental) ingestion exposures from dioxin-contaminated surface soils at Arkwood, Inc. Superfund site are not likely to harm people's health. Current estimates of dioxin exposure suggest non-cancer and cancer effects to the adolescent trespasser are not likely.

BASIS FOR DECISION

Daily exposure dose values for an adolescent-trespasser scenario were evaluated for both the dermal (skin) contact exposure route and the incidental (accidental) ingestion exposure route. Further toxicological and risk calculations indicate that exposures are not likely to be associated with health concerns. Although doses for site area DU 7 slightly exceeded the non-cancer health guideline, they are well-below the levels associated with health effects for all areas of the site (DU 1 – DU 7).

The trespasser scenario evaluated in this assessment incorporated health-protective assumptions, and actual trespasser exposure is likely to be even less frequent than considered in this assessment due to the remote location of the site.

NEXT STEPS

ADH and ATSDR recommend the following for the Arkwood, Inc. Superfund site:

- Continue to post "Warning" signs along all perimeters of the property to inform the community of the potential public health hazards associated with exposure to surface soils.
- Continue to provide public information to educate and increase community awareness about potential residual dioxins remaining at or near the site.
- Any future construction or re-development plans in the community should recognize the potential of past soil

	contamination with dioxins and plan accordingly. For public health protectiveness, plans should include a site-specific evaluation of the available data, land use, and potential for exposures to chemicals in soil.
FOR MORE INFORMATION	If you have concerns about your health, you should contact your health care provider. You can also call ADH at 501-661-2936 and ask for information on the Arkwood, Inc. Superfund site.

Statement of Issues

The Arkwood, Inc. site is listed by the U.S. Environmental Protection Agency (EPA) on the National Priorities List (NPL, *a.k.a.* Superfund). The former wood treatment facility was found to be contaminated with volatile organic compounds (VOCs) and dioxins. In the 1990's, a Record of Decision (ROD) was issued and site remediation was implemented. Recently, due to EPA updates of dioxin guidelines, the soil at the Arkwood site has been reevaluated. EPA Region 6 Superfund Division requested a review of the soil data for public health evaluation. This evaluation includes a review of 28 soil samples collected in October 2014 using the adolescent trespasser exposure scenario. Under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), the Arkansas Department of Health (ADH) has prepared this health consultation to evaluate concentrations of dioxins in soil collected from the Arkwood site.

Background and History

The Arkwood site operated as a wood treating facility from 1962 to 1984, and has remained inactive since its closure. The Arkwood site formerly consisted of a millwork shop, a wood-treating plant that contained chlorinated dibenzodioxins, pentachlorophenol (PCP), creosote and polynuclear aromatic hydrocarbons (PAHs), and a yard for storing treated products before sale. In 1973, the owner of Arkwood leased the process and land to Mass Merchandisers, Inc. (MMI) of Harrison, Arkansas. MMI's lease expired on January 1, 1985, and the plant has not operated since [1]. See Appendix A for historical site figures.

The site is approximately one-half mile southwest of Omaha, Arkansas, and lies to the west of the old U.S. Highway 65. The site consists of approximately 18-acres that slope gently toward the northwest. It is located in a valley on Cricket Creek Road, bounded by ridges covered with native trees. The site is in an area of karst geology that is characterized by subsurface fractures and channels. New Cricket Spring is located down valley immediately west of the site [2]. See Appendix A for site figures.

Currently, the site is secured with a chain link fence and a locked gate. Caution signs posted by the EPA are visible from all sides of the site perimeters. The majority of the site is empty and sparsely covered with grass, gravel, or natural vegetation. Since the site is inactive, the only outdoor activity work that occurs is maintenance, such as mowing. The structures still remaining on-site are the empty office building (guard shack), a small storage shed, a concrete foundation of the former decontamination pad, and an empty treatment area with concrete slabs and three large silos adjacent to the railroad track. The anticipated future land use for the site is industrial (as referenced in the ROD). See Appendix B for site photographs (taken by Arkansas ATSDR Cooperative Agreement staff on October 24, 2014 during a site visit).

Following initial environmental investigations of the site in 1985, EPA listed the Arkwood site on the NPL in 1989. A total of approximately 8,700 cubic yards of soil was excavated and pretreated. From that total, approximately 3,500 cubic yards of soil was transported offsite and incinerated [2]. Since the NPL listing and subsequent remediation, EPA has completed three five-year reviews (FYR) in 2001, 2006, and 2011. An ATSDR public health assessment (PHA) was written in 1988. Currently, only dioxin soil contamination is being reevaluated by the EPA to ensure this site remains in compliance with updated guidelines [2].

Discussion

Exposure to contaminants of concern (COCs) from a Superfund site is determined by examining human exposure pathways. An exposure pathway has five parts:

1. A source of contamination (e.g., hazardous compound(s) in the soil),
2. An environmental medium such as soil, air, or water that can hold or move the contamination,
3. A point at which people come in contact with a contaminated medium,
4. An exposure route, such as dermal (skin) contact with soil, and
5. A population who could come in contact with the contaminants.

An exposure pathway is eliminated if at least one of the five parts is missing and will not occur in the future. For a completed pathway, all five parts must exist and exposure to a contaminant must have occurred, is occurring, or will occur. Past activities resulted in contamination at this Superfund site due to production wastes generated on-site. Primary COCs remaining at Arkwood are dioxins. A completed pathway exists and will be evaluated for trespassers that enter the site and are exposed through dermal (skin) contact or incidental (accidental) ingestion from residual soil on the body through hand to mouth behavior. The most likely scenario is an adolescent trespasser (age 16 – 21), which is a more conservative age group to evaluate since it is considered protective of public health for both adolescent and adult exposures. Given the isolated location and barriers in place, it is unlikely that a smaller child would trespass on-site without adult supervision. Any potential risks associated with environmental exposures to the adolescent trespasser would also be equal to or greater for the child trespasser scenario.

Dioxins

Chlorinated dibenzo-*p*-dioxins (CDDs) are a family of 75 different compounds with similar properties. The CDD family is divided into eight groups of chemicals based on the number of chlorine atoms in the compound. The collective group is often referred to as polychlorinated dioxins. The primary sources of dioxin releases to the environment are the combustion of fossil fuels and wood; the incineration of municipal, medical, and hazardous waste; and certain pulp and paper processes [3].

Dioxins are found everywhere in the environment; they degrade slowly and can persist and accumulate in soils, sediments, and organisms for a long time. Dioxins are found at very low levels in the environment and are often measured in soil, sediment, or biota in units of picograms per gram (pg/g). Most people are exposed to very small background levels of dioxins when they breathe air, consume food or milk, have skin contact with materials contaminated with dioxins, or have contact with cigarette smoke. The actual intake of dioxins from food for any one person will depend on the amount and type of food consumed and the level of contamination. For the general population, more than 90% of the daily intake of dioxins and other dioxin-like compounds comes primarily from meat, dairy products, and fish [3].

When a site is contaminated with dioxins, the effects of all dioxin-like compounds are assumed to be additive due to a similar mode of action. A mathematical method called Toxicity Equivalence (TEQ) is used to assess the risk of exposure to this mixture of dioxin-like compounds. A Toxicity Equivalence Factor (TEF) for each dioxin has been developed to compare its individual relative toxicity to that of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD). To assist with the standardized evaluation of potential toxicity, TEFs have been assigned to dioxin compounds by the World Health Organization (WHO) in 2005 and the EPA in 2010 (see Appendix C) [4, 5]. The TEF for 2,3,7,8-TCDD is defined as one, whereas TEF values for other TCDD-like compounds of equal or lesser toxicity are assigned values ranging between 1.0 and 0.00003 [4, 5]. TEFs are unitless. Based on these assigned relative weights, a summary value for a sample representing all dioxins combined is derived and expressed as the TEQ to 2,3,7,8-TCDD.

The most toxic chemical in the dioxin group is 2,3,7,8-TCDD. The EPA Integrated Risk Information System (IRIS) carcinogenic classification of 2,3,7,8- TCDD is currently under review [6]. The U.S. Department Health and Human Services (DHHS) has determined that it is reasonable to expect that 2,3,7,8-TCDD may cause cancer, and the International Agency for Research on Cancer (IARC) has determined it is carcinogenic to humans. 2,3,7,8-TCDD is not intentionally produced by industry. It can be inadvertently produced in very small amounts as an impurity during the incineration of municipal and industrial wastes and during the manufacture of certain chemicals. 2,3,7,8-TCDD serves as a prototype for the CDDs. CDDs with toxic properties similar to 2,3,7,8-TCDD are called “dioxin-like” compounds [3].

On February 17, 2012, EPA released the final non-cancer dioxin reassessment, publishing a non-cancer toxicity value, or reference dose (RfD), for 2,3,7,8-TCDD in IRIS. The RfD for 2,3,7,8-TCDD (7.0E-10 milligrams per kilogram a day, mg/kg/day) is for immediate use at Superfund sites to ensure protection of human health. Because the RfD is an estimate (with uncertainty spanning an order of magnitude) of the daily exposure of the human population to a potential hazard that is likely to be without risk of harmful effects during a lifetime [3], other calculations such as the site-specific estimated exposure doses may be used to determine potential risks.

In accordance with existing EPA guidance, the new RfD will be used to develop site-specific risk-based cleanup levels at Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) sites. At sites that have been previously investigated or cleaned up under Superfund and RCRA, EPA Regions will consult with EPA Headquarters and will coordinate with state partners to identify, prioritize, and evaluate sites to determine if additional response action is needed [7]. Since an EPA oral cancer slope factor is not available in IRIS, ATSDR's interim soil Cancer Risk Evaluation Guide (CREG) will be based on the California EPA (CalEPA) oral cancer slope factor of 1.3E05 milligrams per kilogram per day $(mg/kg/day)^{-1}$ [8].

ATSDR finalized estimates of exposure levels posing minimal risk to humans (Minimal Risk Levels, or MRLs) for dioxins in 1998, as referenced in the "Toxicological Profile for Chlorinated Dibenzo-p-Dioxins" [4]. MRLs include adjustments to reflect human variability and extrapolation of data from laboratory animals to humans. An acute- (14 days or less), intermediate- (15 – 364 days), and chronic- (365 days or more) duration oral exposure to 2,3,7,8-TCDD has been derived as 2.0E-07 mg/kg/day, 2.0E-08 mg/kg/day, and 1.0E-09 mg/kg/day, respectively [3].

Soil Data

The Potentially Responsible Party (PRP) contractors collected surface soil samples on-site from October 20 – 29, 2014. Contractors for EPA were also present on-site during that same time period to oversee the collection of collocated quality control incremental samples (collocated samples). Soil sampling was performed using a sampling plan based on the 2011 EPA guidance for incremental composite soil sampling. Based on this guidance, the site was divided into a set of seven areas designated as separate Decision Units (DUs), and each was sampled using the incremental sampling methodology (ISM) [9]. See "Arkwood Figure Depicting Decision Units (DU)" in Appendix A for location of each DU at the site.

A total of 28 surface soil samples were collected from zero to six inches in depth below ground surface. Analysis of soil samples was based on EPA Method 1613B to determine a concentration for 2,3,7,8-substituted dibenzo-p-dioxins and dibenzofurans (CDDs/CDFs). The PRP used Vista Analytical Laboratory, and results were calculated for total TEFs by applying the standard TEF values adopted by WHO (2005) and EPA (2010) (as seen in Appendix C) [4, 5, 9]. Based on all sample results, the maximum concentration found is 7,330 picograms per gram (pg/g) (DU 7) and the minimum concentration found is 59.7 pg/g (DU 2); the range for the whole site is 7,270.3 pg/g. The average (or mean) for all samples is 1,174.8 pg/g, with a median between 602.0 – 610.0 pg/g.

Since the samples vary so widely in concentrations, the outlier sample was further separated in the exposure scenario to better represent exposures from the overall site. DU 7 contained the samples with the highest concentrations, whereas other DUs across the site were more

consistently similar. DU 1 – DU 6 are located from the main entrance and spread across the site; most of the site is a wide-open area. DU 7 is located near the train tracks behind the concrete pad containing three large silos. See Appendix A for figures of the locations. The range for DU 1 – DU 6 is only 2,780.3 pg/g and the average is 946.9 pg/g. The range for DU 7 is only 5.0 pg/g and the average is 7,327.5 pg/g.

EPA split samples were: E – DU 2 – SU 28, E – DU 5 – SU 1, E – DU7 – SU 1 [10]. While there are some differences between EPA's split sample and Vista Analytical results, they were within acceptable limits (within an order of magnitude or less difference). See Table 1 for a summary of the maximum and average dioxin concentrations used in each DU at the Arkwood site (compiled from the Vista Analytical data results).

Some limitations exist for the surface soil data. It was noted during the soil collection phase that the on-site soil was somewhat rocky, so more soil than typically used in sampling was collected to capture an accurate soil reading. Another limitation includes future site-use. If new construction requires digging more than 6 inches below ground surface, the dioxin soil concentration deeper than 6 inches is unknown. For public health protectiveness, future construction or re-development plans in the community should recognize the potential of past dioxin soil contamination and plan accordingly, which may include site-specific evaluation of all available data, land use, and potential for exposures to chemicals in soil.

Table 1. Summary of Maximum Dioxin Concentrations at each Decision Unit (DU) for Arkwood Superfund Site Soil Samples

Decision Unit (DU)	Sample ID	Maximum Dioxin TEQ* pg/g	Average Dioxin TEQ* per DU pg/g
1	DU1 SU4	1110	843
2	DU2 SU19	610	238.8
3	DU3 SU2	1640	804
4	DU4 SU1	1860	1231
5	DU5 SU1-1	1780	1673.3
6	DU6 SU2	2840	1990
7	DU7 SU1	7330	7327.5

TEQ = Toxicity Equivalence; pg/g = picograms per gram; Soil samples collected October 2014,
*All TEQ values above the Cancer Risk Evaluation Guide (CREG) of 5.4 pg/g

ATSDR chronic EMEG (Environmental Media Evaluation Guide) for dioxins in soil is 50 pg/g for a child or 700 pg/g for an adult. For cancer assessment, the ATSDR soil CREG (Cancer Risk Evaluation Guide for 1E-06 excess cancer risk) is 5.4 pg/g. To identify potential public health risks from dioxin-contaminated soil exposure through dermal (skin) contact and/or incidental

(accidental) ingestion, daily exposure dose values for the adolescent trespasser scenario were calculated.

Since DU 7 was found to contain a higher concentration of dioxin contamination than what was seen in the rest of the site samples (DU 1 – DU 6), it will be evaluated separately to present an accurate exposure of the overall site. An average of all soil samples in DU 1 – DU 6 (946.9 pg/g) was used to calculate daily exposure dose values, along with the average of DU 7 (7,327.5 pg/g) soil samples calculated separately.

Table 2. Arkwood Superfund Site: Soil Exposure Calculations for Adolescent Trespasser (16 – 21 years) for Potential Dermal Contact Risks (Using mean dioxin concentrations for segmented portions of site)

Site Area	Dermal Exposure Dose [Mean] mg/kg/day	Hazard Quotient [Mean] (unitless)	Cancer Risk [Mean] (unitless)
DU 1 – DU 6	1.2E-10	0.20	9.7E-07
DU 7	1.0E-9	**1.43**	7.5E-06

mg/kg/day = milligrams per kilogram per day

For the dermal pathway, the exposure dose calculation used an exposure factor of 96 days per year (approximately eight days per month, or 0.3) for a total of five years. A body weight of 71.6 kilograms (kg) was attributed to the adolescent exposure dose calculations. The total soil adherence attributed to the adolescent was 5,583 squared centimeters (cm^2). This was based on the 50^{th} percentile skin surface area of exposed skin using the face, hands, forearms, lower legs, and feet.

Table 3. Arkwood Superfund Site: Soil Exposure Calculations for Adolescent Trespasser (16 – 21 years) for Potential Incidental Ingestion Risks (Using mean dioxin concentrations for segmented portions of site)

Site Area	Ingestion Exposure Dose mg/kg/day	Hazard Quotient (unitless)	Cancer Risk (unitless)
DU 1 – DU 6	3.5E-10	0.5	2.9E-06
DU 7	2.7E-09	**3.8**	2.2E-05

mg/kg/day = milligrams per kilogram per day

For the incidental (accidental) ingestion pathway, the exposure dose calculation used an intake rate of 100 milligrams per day (mg/day) for the adolescent trespasser scenario [the mean central tendency exposure (CTE)]. As with the dermal pathway calculations, further potential risk calculations were evaluated to show potential risk associated with exposure to this site.

Total dioxin TEQ's do not have assigned health comparison values; the values for 2,3,7,8-TCDD were used as the surrogate values for comparison purposes. The EPA RfD (of 7.0E-10 mg/kg/day) was used to compare to the estimated daily calculated exposure doses for both the dermal and incidental ingestion pathways. [The EPA RfD was used in this evaluation because it is a lower, more conservative value than ATSDR's Minimal Risk Level (MRL) and represents the most current available science.]

To put the calculated exposure doses into a meaningful context for non-cancer effects, the Hazard Quotient (HQ) was calculated for each potentially exposed adolescent trespasser. An HQ is the average daily intake divided by a chemical specific RfD set by the EPA. If the HQ for a chemical is equal to or less than one, it is believed that there is no appreciable risk that non-cancer health effects will occur. If the HQ exceeds one, there is some possibility that non-cancer effects may occur, although an HQ above one does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfD values. The larger the HQ value, the more likely it is that an adverse effect may possibly occur. The RfD for 2,3,7,8-TCDD is 7.0E-10 $(mg/kg/day)^{-1}$. All calculated HQ values for each site area and exposure scenario can be found in Table 2 and Table 3. While the HQ values determined for the site area DU 1 – DU 6 are below 1.0 for both dermal contact and incidental ingestion, the HQ values determined for site area DU 7 are slightly above 1.0 for both dermal contact and incidental ingestion. Although doses for DU 7 exceeded the non-cancer health guideline, they are well-below the levels associated with health effects for all areas of the site (DU 1 – DU 7).

The RfD for TCDD was derived from human reproductive and developmental toxicity data from the two epidemiologic studies by Mocarelli et al., 2008 and Baccarelli et al., 2008 [11], respectively. Both studies have an uncertainty factor of 30. Review of the available toxicology and site-specific information on the infrequent trespasser exposure likely at this site verifies non-cancer health effects associated with dioxin exposures at this site are not likely.

Because 2,3,7,8-TCDD is reasonably anticipated to be carcinogen, a potential cancer risk was calculated using each average site area exposure dose values (based on the maximum concentration for TEQ found in each site area). For Cancer Risk (CR) ranges, the target cancer risk range (1.0E-04 to 1.0E-06) that EPA uses for making risk management decisions about site remediation was considered by ADH. These values were based on a daily exposure dose over five years of a person's 78-year lifespan. All calculated CR values for each DU and exposure scenario can be found in Table 2 and Table 3. The total CR values for ingestion and dermal contact with soils in DU 1 – DU 6 and DU 7 are within the target risk range of 1.0E-04 to 1.0E-06 indicating that cancer effects from this exposure are not likely. See Appendix D for individual variables and equations.

Water Data

Along with the soil reassessment, a groundwater dye-tracing test was conducted during the 2014 investigation. Residual wastes at a waste site in karst geology are commonly trapped or held

with the epikarst (also called the epikarstic zone) [12]. In 1991, the initial groundwater tracing study at the Arkwood site was conducted due to operational wastes dumped at the site near the karst. PCP contaminated wastes were dumped into a sinkhole in the middle of the Arkwood site. During remediation work, debris was removed from the sinkhole and it was capped with concrete. Several shallow wells were drilled into the epikarstic zone around the sinkhole. Then ozonated water was introduced into some of the shallow wells to accelerate waste treatment being provided for water discharging from New Cricket Spring. This injected water was designed to ensure that New Cricket Spring would have a sufficient flow rate to allow the treatment plant to operate [12].

A supplemental groundwater tracing study was conducted over a seven week period to quantify groundwater flow paths from the former sinkhole area at the Arkwood site to New Cricket Spring. The study was part of ongoing groundwater remediation activities at the site. Two groundwater traces were performed as part of this study, and two dye introduction wells are about 22 feet apart and both located in the epikarstic zone. The first dye-trace study consisted of a one-pound fluorescein mixture introduced into “Former Sinkhole Area Well A”. The second dye-trace study consisted of a four-pound rhodamine WT (RWT) mixture introduced into “Former Sinkhole Area Well B”. Both fluorescein and RWT are fluorescent dyes often used as water tracers in aquifer characterization and to determine fate and transport.

The first detected arrival of the dyes was within four to eight hours, and the arrival of the peak concentration of the dyes was within eight to 16 hours. Dye injected into both Well A and Well B was detected in New Cricket Spring. Dyes were not detected in Cricket Spring, the two Railroad Tunnel Spring discharges, or in the Walnut Creek valley from either Well A or Well B.

The results from the supplemental groundwater tracing study confirmed that groundwater in the vicinity of the former on-site sinkhole discharges to New Cricket Spring only and does not flow to other springs or water sheds in that area [12]. No complete exposure pathway for the groundwater exists since no drinking water source comes from New Cricket Spring; therefore, groundwater will not be further evaluated in this health consultation. In addition, New Cricket Spring is not used for recreational purposes such as fishing or swimming. Further precautions such as establishing a deed restriction for the New Cricket Spring area and securing the area with fencing have been proposed by MMI contractors for the future.

Community Health Concerns

There was a previous knowledge of the site contamination by the community, since past remediation events at the Arkwood Superfund site had been completed by 1995. An active campaign to notify and educate local residents prior to the original site clean-up was conducted. In 1990, several public meetings and a Remedial Investigation (RI) open house was hosted by

EPA where community concerns were noted. Based on noted community concerns and petitions, EPA developed a "Final Revised Community Relations Plan" in 1992 that was implemented during the remediation process [13]. ADH has not received any community concerns regarding this site [2]. ADH continues to work with EPA and ADEQ regarding public health education activities in the community, as needed or requested.

Child Health Considerations

In communities with environmental contamination, children can be at greater risk than adults for exposure to hazardous substances. A child's behavior and lifestyle influence exposure. Small children crawl on floors, put things in their mouths, play close to the ground, and spend more time outdoors. Children drink more fluids, eat more food, breathe more air per unit of bodyweight, and have a larger skin surface area in proportion to their bodyweight.

In addition to physical and behavioral differences, children's metabolic pathways, especially in the first few months after birth, are less developed than those of adults. In some instances, children are less susceptible to environmental toxicants, but in others, they are more vulnerable. Children are rapidly growing and developing during the first months and years of life. Some organ systems, especially the nervous and respiratory systems, may experience permanent damage if exposed to high concentrations of certain contaminants during this period. In addition, children are less able to avoid hazards because of their lack of knowledge of potential dangers and their dependence on adults for protection.

Experimental studies in animals have demonstrated that exposure to dioxins can cause neurodevelopmental, neurobehavioral, and immunological effects in new born and young animals. In humans, some studies, but not all, have reported similar effects in neonates and infants, although overall, the evidence for these effects in humans is inconclusive [14].

It is prudent public health policy to minimize dioxin exposures in children. The most significant source of dioxin exposure in neonates and young children is likely from breast feeding. Breast feeding provides many nutritional, immunological, social, and other benefits that make it the preferred source of nutrition for infants. Although dioxins can be transferred from breast milk to an infant, the American Academy of Pediatrics recommends that women do not stop breast feeding on the basis of exposure to low-level environmental chemical agents [15].

For this site evaluation, the most likely scenario is an adolescent trespasser (age 16 – 21) due to the location and current state of inactivity. The site is secured with a chain link fence and a locked gate at the front of the site. Caution signs posted by the EPA are visible from all sides of the site perimeters. The majority of the site is empty and sparsely covered with grass, gravel, or natural vegetation. Given the isolated landscape and barriers in place, it is unlikely that a smaller child would trespass on-site without adult supervision; however a group of adolescents may use

the site for recreational purposes. Any potential risks associated with environmental exposures to the adolescent trespasser would also be equal to or greater for the child trespasser scenario, and therefore represent a conservative potential for public health risks.

Conclusions

ADH and ATSDR conclude that current dermal (skin) and/or incidental (accidental) ingestion exposures from dioxin-contaminated surface soils at Arkwood, Inc. Superfund site are not likely to harm people's health. Current estimates of dioxin exposure suggest non-cancer and cancer effects to the adolescent trespasser are not likely. Daily exposure dose values for an adolescent-trespasser scenario were evaluated for both the dermal (skin) contact exposure route and the incidental (accidental) ingestion exposure route. Further toxicological and risk calculations indicate that exposures are not likely to be associated with health concerns. Although doses for site area DU 7 slightly exceeded the non-cancer health guideline, they are well-below the levels associated with health effects for all areas of the site (DU 1 – DU 7).

The trespasser scenario evaluated in this assessment incorporated health-protective assumptions, and actual trespasser exposure is likely to be even less frequent than considered in this assessment due to the remote location of the site.

Recommendations

ADH and ATSDR recommend the following for the Arkwood, Inc. Superfund site:

- Continue to post "Warning" signs along all perimeters of the property to inform the community of the potential public health hazards associated with exposure to surface soils.
- Continue to provide public information to educate and increase community awareness about potential residual dioxin remaining at or near the site.
- Any future construction or re-development plans in the community should recognize the potential of past dioxin soil contamination and plan accordingly. For public health protectiveness, plans should include a site-specific evaluation of the available data, land use, and potential for exposures to chemicals in soil.

Public Health Action Plan

The purpose of the Public Health Action Plan (PHAP) is to ensure that this health consultation not only identifies any public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. The PHAP implemented by ADH with regards to the Arkwood, Inc. Superfund site is as follows:

Completed Actions

- Corresponded with EPA and ADEQ regarding information and data relevant to the site.
- Evaluated potential exposure pathways within the surrounding community.
- Met with contractors conducting soil sampling and conducted a site visit to the Arkwood Superfund site and surrounding areas in the community on October 24, 2014.

Future Activities

- Continue to analyze future data, as available, for public health review.
- Continue to educate the public and address community requests or concerns in regards to this site, as needed.

REPORT PREPARATION

This Health Consultation for the Arkwood Inc. Superfund site (Omaha, Boone County, AR**)** was prepared by the Arkansas Department of Health (ADH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication.

Author(s)

Health Assessor
Ashley Whitlow, M.S.
Arkansas Department of Health
4815 West Markham, Mail Slot 32
Little Rock, AR 72205

Designated Reviewer
Lori Simmons, M.S.
Arkansas Department of Health
4815 West Markham, Mail Slot 32
Little Rock, AR 72205

ATSDR Technical Project Officer(s)

Rob Robinson, MBA
Environmental Health Scientist, Regional Representative
Technical Project Officer
Division of Community Health Investigations

ATSDR Reviewer(s)

Annmarie DePasquale, MPH
Environmental Health Scientist
Associate Director for Science, Central Branch
Division of Community Health Investigations

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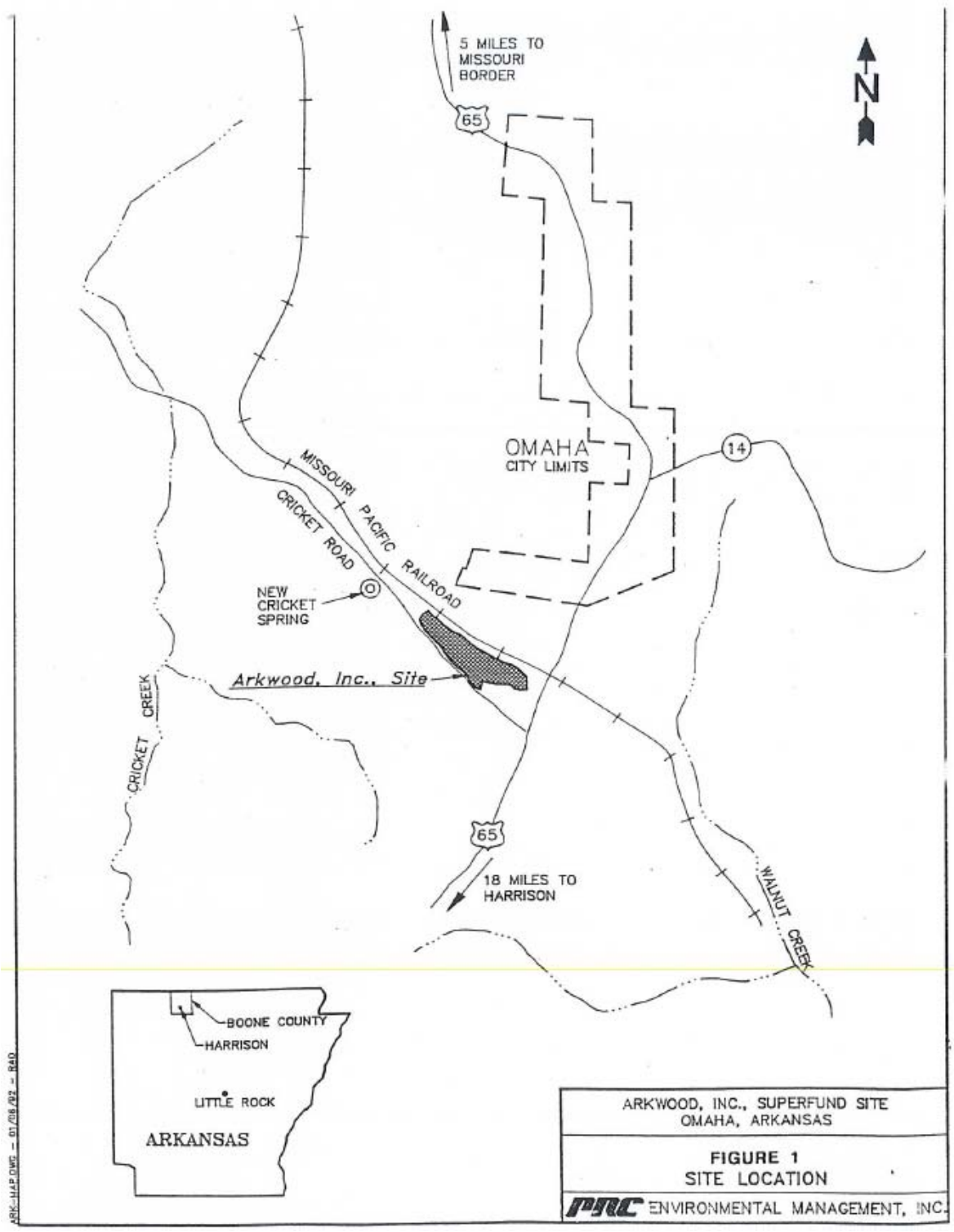
Appendix A: Historical Site Figures and Decision Unit Figure

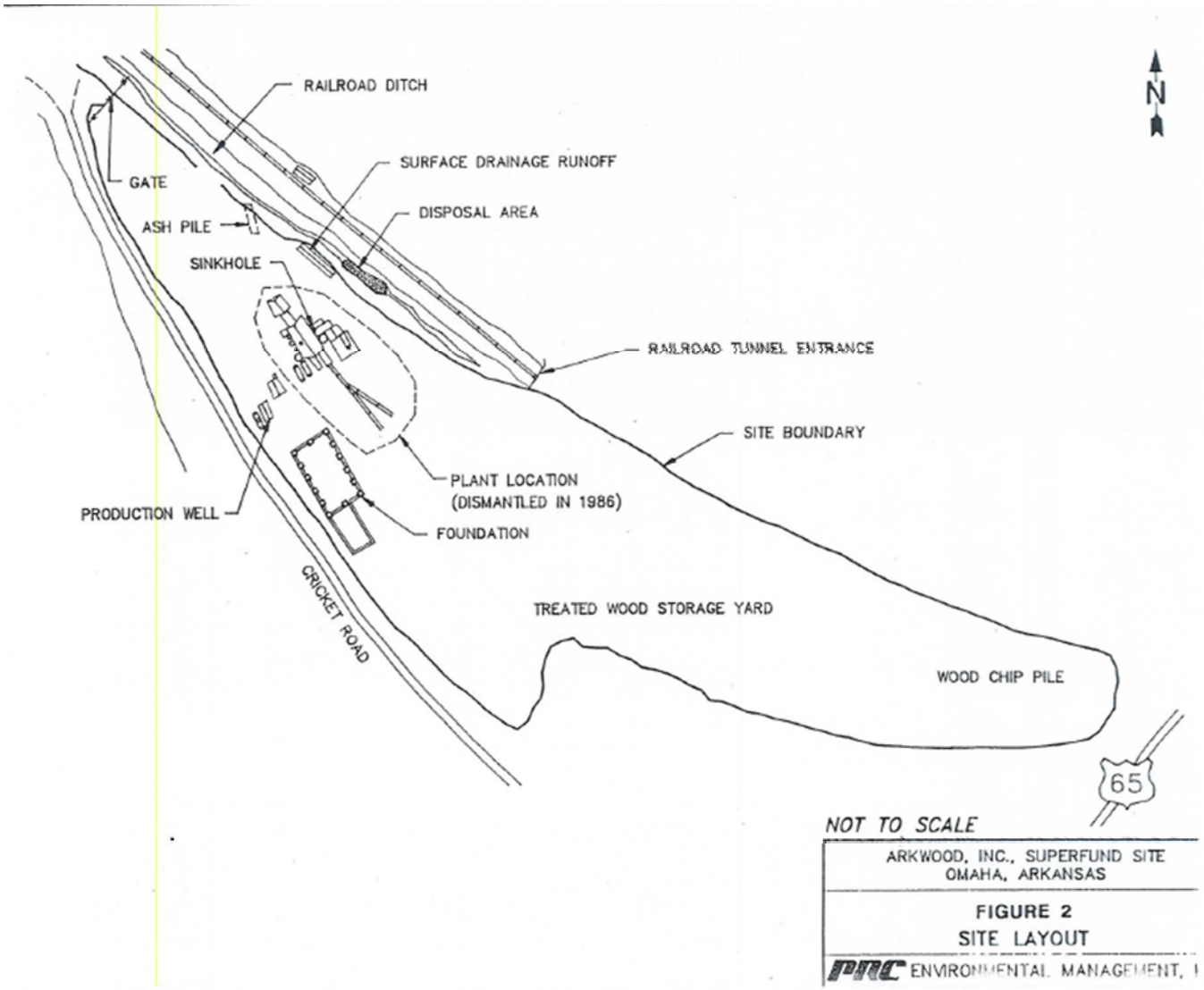
Source: *U.S. Environmental Protection Agency (EPA) Superfund Division (date of aerial figure unknown).*

Source: *U.S. Environmental Protection Agency (EPA) Superfund Division (date of aerial figure unknown).*

Source: *U.S. Environmental Protection Agency (EPA) Superfund Division (date of aerial figure unknown).*



Source: Historical Figure from EPA Region 6: "Final Revised Community Relations Plan, Arkwood, Inc., Superfund Site, Omaha, AR" Prepared by PRC Environmental Management, Inc. June 8, 1992.



Source: Historical Figure from EPA Region 6: "Final Revised Community Relations Plan, Arkwood, Inc., Superfund Site, Omaha, AR" Prepared by PRC Environmental Management, Inc. June 8, 1992.

Arkwood Figure Depicting Decision Units (DU) 1 through 7

Source: Draft Dioxin Reassessment at Arkwood, Inc. Superfund Site; Risk Evaluation of Analytical Data from Decision Unit Sampling; March 31, 2015.

Arkwood Figure Depicting Close-up View of Decision Unit (DU) 7

Source: Draft Dioxin Reassessment at Arkwood, Inc. Superfund Site; Conceptual Site Model April 2014

Appendix B: Site Photographs from October 24, 2014

Main entrance to Arkwood site. Gate locked to public access.

Sign posting on all fences of Arkwood site.

View of guard shack (office) and storage shed.

View of concrete foundation of the former decontamination pad (storage shed in background).

View of concrete foundation of the former decontamination pad.

View of former sinkhole location where dye-injection wells are located.

Side view of the empty treatment area with concrete slabs and three large silos adjacent to the railroad track.

Front view of the empty treatment area with concrete slabs and three large silos adjacent to the railroad track. Contractors used this as work space while collecting samples.

View of south side of Arkwood site. Former wood-chip pile was located near the perimeter close to the tree line.

View of north side of Arkwood site.

View of west perimeter of Arkwood site.

View of rail road lines on east side past Arkwood perimeter.

View of drainage discharge into New Cricket Spring off-site of Arkwood property.

View of New Cricket Spring off-site of Arkwood property (across the street from Arkwood Waste Water Treatment Plant).

View of drainage ditch beside Arkwood Waste Water Treatment Plant.

View of Arkwood Waste Water Treatment Plant (fenced and locked; not accessible to the public).

Appendix C: Toxicity Equivalence Factors of Dioxins and Dioxin-like Compounds

Recommended toxicity equivalence factors (TEFs) for human health risk assessment of polychlorinated dibenzo-*p*-dioxins, dibenzofurans, and dioxin-like polychlorinated biphenyls.

Compound	**TEF**
Polychlorinated dibenzo-*p*-dioxins (*PCDDs)*	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Polychlorinated dibenzofurans (*PCDFs)*	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003
Polychlorinated biphenyls* (*PCBs)*	
3,3',4,4'-TCB (77)	0.0001
3,4,4',5-TCB (81)	0.0003
3,3',4,4',5-PeCB (126)	0.1
3,3',4,4',5,5'-HxCB (169)	0.03
2,3,3',4,4'-PeCB (105)	0.00003
2,3,4,4',5-PeCB (114)	0.00003
2,3',4,4',5-PeCB (118)	0.00003
2',3,4,4',5-PeCB (123)	0.00003

Source:
EPA "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin and Dioxin-Like Compounds," Office of the Science Advisor, Risk Assessment Forum; December 2010.

Van den Berg M., Birnbaum L.S., Denison M., De Vito M., Farland W., et al. "The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds," Toxicological Sciences; 93(2):223–241; 2006

Appendix D: Exposure Dose Calculations

Exposure Dose Equation for Dermal (Skin) Soil Contact from Arkwood Superfund Site

DAD = DA x EV x SA/ BW

DAD = Dermal Absorbed Dose (milligrams per kilogram per day, mg/kg/day)
DA = Absorbed Dose (milligrams per squared centimeter, mg/cm^2)
EV = Event Frequency (days)
SA = Surface area available for contact (squared centimeter, cm^2)
BW = Body Weight (kilograms, kg)

Adolescent-Trespasser Scenario Variables*:
EV = 96/365 = 0.3
SA = 5,583 squared centimeters (50^{th} percentile skin surface area of exposed skin using the face, hands, forearms, lower legs, and feet)
BW = 71.6 kg

*Using ATSDR Exposure Dose Guidance (October 2015) and ATSDR Soil Dermal Exposure Excel Calculator

Exposure Dose Equation for Incidental Soil Ingestion from Arkwood Superfund Site

ED = (C x IR x EF x BF x CF) / BW

ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
C = Contaminant Concentration (milligrams per kilogram, mg/kg)
IR = Intake Rate of Soil Digested per Day (milligrams per day, mg/day)
EF = Exposure Factor (unitless)
BF = Bioavailability Factor (unitless)
CF = Conversion Factor (1E-06)
BW = Body Weight (kilograms, kg)

Adolescent-Trespasser Scenario Variables*:
C = Average TEQ Concentration at each Decision Unit Area (DU 1 – DU 6 and DU 7)
IR = 100 mg/day
EF = 0.26; CF = 1E-06
BW = 71.6 kg

*Using ATSDR Exposure Dose Guidance (January 2015) and ATSDR Soil Ingestion Exposure Excel Calculator

Hazard Quotient Equation for Estimating Non-Cancer Health Effects

HQ = ED / RfD

HQ = Hazard Quotient (unitless)
ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
RfD = Reference Dose (milligrams per kilogram per day, mg/kg/day)

RfD for 2,3,7,8-TCDD = 7.0E-10 $(mg/kg/day)^{-1}$

Lifetime Cancer Risk Equation for Estimating Possible Carcinogen Effects

LCR = ED x CSF x (estimated exposure years / 78 years lifetime)

LCR = Lifetime Cancer Risk (unitless)
ED = Exposure Dose (milligrams per kilogram per day, mg/kg/day)
CSF = Cancer Slope Factor (1 / milligrams per kilogram per day, $mg/kg/day^{-1}$)
Estimated exposure years = 5 years
Estimated exposure years = 78 years (lifetime)

CSF for 2,3,7,8-TCDD = 1.3E05

Source :
U.S. Environmental Protection Agency. Exposure Factors Handbook: 2011 Edition. Accessed at: http://www.epa.gov/ncea/efh/report.html.

California Environmental Protection Agency (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA). Technical Support Document for Describing Available Cancer Potency Factors for 2,3,7,8-Tetrachlorodibenzo-o-dioxin and related compounds. 2009.

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Greetings,

You are receiving a document from the Agency for Toxic Substances and Disease Registry (ATSDR). We are very interested in your opinions about the document you received. We ask that you please take a moment now to complete the following ten question survey. You can access the survey by clicking on the link below.

Completing the survey should take less than 5 minutes of your time. If possible, please provide your responses within the next two weeks. All information that you provide will remain confidential.

The responses to the survey will help ATSDR determine if we are providing useful and meaningful information to you. ATSDR greatly appreciates your assistance as it is vital to our ability to provide optimal public health information.

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LCDR Donna K. Chaney, MBAHCM
U.S. Public Health Service
4770 Buford Highway N.E. MS-F59
Atlanta, GA 30341-3717
(W) 770.488.0713
(F) 770.488.1542